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WATER BORNE TYPHOID FEVER AT GREENEVILLE, TENNESSEE¹

By C. N. HARRUB²

The water supply of Greeneville, Tennessee, is obtained from a spring which emerges from beneath a limestone ledge almost in the center of the city. It is located in the bottom of a natural basin toward which a large portion of the town drains. A concrete pool has been constructed at the spring. A portion of this pool is covered by the intake house, but about half of it is uncovered. From this place the water is conducted by a pipe line to another open pool at the pumping station. This second pool serves as a suction well, and the water is pumped from it to a standpipe, whence it flows by gravity to the city.

The sanitary survey shows a very unsatisfactory condition. As previously mentioned, the spring is in practically the lowest spot in town and is surrounded by dwellings on all sides. The concrete curb around the spring does not prevent the entrance of surface drainage which runs toward the spring from a large portion of the town. A concrete storm sewer has been constructed to discharge into the stream a short distance below the spring. A fence across the stream just below the end of the sewer so obstructs the flow in times of heavy rain that the storm water is backed into the spring.

At the pumping station the water supply is separated from a very filthy creek only by a concrete wall, through which two overflow pipes are placed. At times of high water in the creek these overflow pipes are sometimes submerged, and the only means employed to keep the creek from flowing directly into the pump suction well is to stuff cotton waste into the overflow pipes.

Since the establishment of the public water supply many private wells previously used have been abandoned and until such use was

¹ Discussion is invited and should be sent to the Editor.

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finally forbidden by the city they were quite commonly converted into cesspools. One well so used was shown by test to be directly connected with the spring.

Until 1913 the water was used without any treatment. During that year the city experienced a severe epidemic of typhoid fever, which the evidence indicated was due to impure water. Analyses of the spring water indicated sewage contamination. A calcium hypochlorite plant was then installed to make the water safe, and undoubtedly was a very considerable factor in checking that epidemic. The original plant consisted of a grinder, mixing tank, two solution tanks and orifice box. The solution was fed through about 30 feet of half-inch pipe into the suction pool near the end of the suction main.

Early in May, 1920, typhoid fever began to appear with unusual frequency. However, until June 8 the only effort made to prevent the spread of the disease was the application of antityphoid vaccine to other members of the family where a case of typhoid occurred and exercising the usual care in disposing of excretions from the patient. On that date an appeal was made to the State Board of Health for assistance. The author, to whom the request was referred, immediately went to Greeneville, and in 24 hours was on the ground to investigate the epidemic and render any assistance possible in checking it.

The first step in the investigation was an examination of the water supply. This revealed the conditions above described, and also the fact that the hypochlorite plant was badly out of order. One of the solution tanks was completely out of commission, the bottom having fallen out. This made it necessary to use one solution tank continuously, feeding from it while making up the new batch of solution, and allowed no period for settling. The result of this was a variable strength solution, clogged feed lines and interrupted application of the solution to the water. The trouble was increased by occasional stirring of the solution.

It was also found that much less available chlorine was actually applied to the water than was thought. No records of the amount of hypochlorite used or frequency of preparing solutions were kept, and no definite information as to the dosage could be obtained. It was only by checking up the quantity purchased for the year that the average dose could be determined. This average dose, 0.07 p.p.m. available chlorine, was far too small to produce a safe water.

On account of the previous history of the water supply, which for the past eight years has always been contaminated, it was thought to be the probable cause of the present epidemic of typhoid fever. Consequently, one of the emergency chlorinators, recently furnished the State Board of Health by the Wallace & Tiernan Company, Inc., of New York, had been taken to Greeneville, and in order to accomplish efficient disinfection of the water it was considered necessary to install it. As the State Board of Health had up to that time been unable to obtain delivery of any liquid chlorine, an attempt had been made to obtain some in the vicinity of Greeneville. Through the courtesy of the City Health Officer of Kingsport a 100-pound cylinder of liquid chlorine was obtained from that place and put into service on June 12. The apparatus was set to feed the chlorine at a calculated rate of 0.6 p.p.m. on the basis of a half million gallons per day pumpage. Actual check showed the rate to be 0.58 p.p.m. Subsequent test indicated an excess of about 0.2 p.p.m. and the dose was consequently reduced to about 0.4 p.p.m. Bacteriological analyses conducted over a period of nine days indicated that the reduced amount was producing a practically sterile water with no fermentation in 10 cc. quantities of water planted in lactose broth, and it was continued without further change.

Up to the time of installing the chlorinator there had been 57 cases of typhoid fever and six deaths in a period of approximately nine weeks. During the eight days following 3 new cases were reported, the last one being reported on June 20. As the incubation period for typhoid fever is from twelve to fourteen days, it is apparent that no new infections could have occurred after the chlorinator was put in operation.

The dates of onset of the various cases are shown in table 1.

In addition to the 60 cases and six deaths recorded above, there was one case in the county outside of Greeneville which was fatal. This made a total of 61 cases and seven deaths during the epidemic. This corresponds to a morbidity rate of 2033 per 100,000 population, and a death rate of 233 per 100,000 population, and a mortality percentage of 11.5.

A complete investigation of the epidemic was made to determine any other possible source of the infection, but all the evidence collected pointed to the water supply as the responsible agent. The immediate checking of the epidemic by the proper treatment of the water supply fully confirmed this conclusion.

TABLE 1
Cases of typhoid fever, Greeneville, Tennessee, 1920

DATE	CASES	WEEK ENDING	CASES FOR THE WEEK
April 6.....	1	April 10	1
April 15.....	2	April 17	2
April 20.....	1	April 24	1
April 26.....	1		
April 30.....	2		
May 1.....	5*	May 1	8
May 2.....	2*		
May 3.....	1		
May 4.....	2		
May 5.....	1*		
May 7.....	3*		
May 8.....	1	May 8	10
May 10.....	1		
May 14.....	1		
May 15.....	2*	May 15	4
May 16.....	1		
May 17.....	1		
May 19.....	1		
May 21.....	1		
May 22.....	1	May 22	5
May 23.....	1		
May 27.....	1*		
May 28.....	1		
May 29.....	1	May 29	4
May 30.....	5		
June 1.....	1		
June 2.....	1		
June 3.....	1		
June 4.....	2		
June 5.....	1	June 5	11
June 6.....	2		
June 7.....	4		
June 8.....	2		
June 10.....	2		
June 12.....	1	June 12	11†
June 17.....	1		
June 18.....	1	June 19	2
June 20.....	1	June 26	1
Totals.....	60		60

* One of these cases died. Total, 6 deaths.

† Chlorinator installed June 12.

The typhoid fever history of Greene County, in which Greenville is located, is given by districts for the years 1914–1920, inclusive, in table 2.

It is not possible to secure an accurate estimate of the population of the 10th District, which is the district in which Greenville is located, of Greene County. However, the 1910 census gives Greene-

TABLE 2
Deaths in Greene County from typhoid fever by districts

DISTRICTS	1914	1915	1916	1917	1918	1919	JAN- UARY- JULY, 1920	TOTAL
1st	1	—	1	—	—	—	—	2
2nd	1	1	—	—	—	—	—	2
3rd	—	1	—	1	—	—	—	2
6th	—	2	—	—	—	—	—	2
7th	1	1	—	—	1	2	1	6
9th	1	—	—	—	—	—	—	1
10th*	1	2	1	3	3	3	7	20
11th	1	3	—	—	3	—	—	7
12th	—	—	1	2	2	1	—	6
14th	1	—	—	1	—	—	—	2
15th	1	2	—	—	—	—	—	3
16th	1	—	2	—	1	2	1	7
17th	1	1	1	—	1	—	1	5
18th	—	—	2	—	1	—	3	6
19th	—	—	—	1	—	—	—	1
20th	—	—	—	—	—	1	—	1
21st	1	—	1	4	—	1	—	7
22nd	—	—	1	—	1	—	1	3
24th	—	—	—	1	—	—	—	1
26th	1	—	—	—	—	—	—	1
Totals.....	12	13	10	13	13	10	14	85

No deaths from typhoid reported in the 4th, 5th, 8th, 13th, 23rd and 25th districts.

* Includes Greenville.

ville a population of 1920, and Greene County a population of 31,083. Hence, it is fair to assume that the 10th District does not contain more than 10 per cent of the county's total population.

In the period from January 1, 1914, to July 31, 1919, the records of the Bureau of Vital Statistics show that with the above estimated 10 per cent of the population the 10th District has had 23.5 per cent.

of the total typhoid deaths in the county, or more than twice the county incidence.

No record of the epidemic of 1913 is available, as the Bureau of Vital Statistics was not established until 1914, and no local records were kept, but it was unofficially stated by officials and residents of Greeneville that there were about 120 cases at that time.

The study of this epidemic of water-borne typhoid fever should be of especial interest to water-works superintendents, as it indicates so pointedly the necessity of constant, careful watch over the operation of the disinfectant plant if efficient protection is to be afforded against a polluted water.

In justice to the city it must be added that as a result of the investigation by the State Board of Health, the city purchased a liquid chlorine apparatus and has taken steps to provide for filtration of the water supply.